AD-A101 581 HARRY DIAMOND LABS ADELPHI MD F/G 9/1
BIPOLAR TRANSISTOR AND DIODE FAILURE TO ELECTRICAL TRANSIENTS----ETC(U)
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

An investigation of the predictive capability of a new Air Force Weapons Laboratory model for transistor and diode failure under reverse bias was initiated. A comparison with the junction capacitance damage model shows a doubled improvement at high confidence levels based on an Army-generated population of experimental damage data.

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CONTENTS

FIGURES

1. INTRODUCTION

A recent Air Force Weapons Laboratory (AFWL) document, Electronic Component Modeling and Testing Program, AFWL-TR-78-62 Pt.1 (March 1980), contains a new model for predicting bipolar transistor and diode failure for reverse junction bias. This paper examines the capability of this model using as a baseline a library of experimental damage data for devices from the front ends of an array of Army tactical multichannel radios.

2. EXAMINATION

The new model is implemented as follows:

(1) Calculate doping concentration from room temperature breakdown voltage:

$$N_D = 4.49 \times 10^{18} V_{BD}^{-1.5}$$

where

N_D = doping concentration on lightly doped side of junction (inverse cubic centimeters),

V_{BD} = room temperature breakdown voltage (volts).

(2) Calculate breakdown voltage at critical failure temperature:

$$V_{BDC} = 4.07 \times 10^{12} N_D^{-0.67}$$

where

V_{BDC} = breakdown voltage at critical failure temperature (volts).

(3) Calculate space charge resistivity:

$$\rho_{SC} = 2.48 \times 10^{25} N_D^{-1.8}$$

where

ρ_{SC} = space charge resistivity (ohm-square centimeters).

(4) Calculate bulk resistivity:

$$\rho_{BLK} = 3.61 \times 10^{10} N_D^{-0.81} \quad ,$$

where

ρ_{BLK} = bulk resistivity (ohm-square centimeters).

(5) Calculate failure current density at 100 ns:

Emitter-to-base junction:

$$J_F = 3.84 \times 10^{-11} N_D^{0.88} \quad ,$$

where

J_F = failure current density at 100 ns (amperes/square centimeter).

Collector-to-base or diode junction:

$$J_F = 8.25 \times 10^{-11} N_D^{0.88} \quad .$$

(6) Calculate junction area:

Emitter-to-base junction:

Priority 1

$$\text{Area} = 1.47\left(2.3 \times 10^{-6} C_{O_{EB}} V_{BD}^{0.67}\right)^{1.05} \quad ,$$

where

$C_{O_{EB}} = C_{RE} V_{RF}^{0.5}$ = corrected emitter-to-base capacitance (picofarads),

C_{RE} = emitter-to-base capacitance at rated voltage (picofarads),

V_{RF} = rated voltage (volts),

V_{BD} = rated emitter-to-base breakdown voltage (volts).

Priority 2

$$\text{Area} = 6.34 \times 10^{-4} I_{MAX}^{0.82} \quad ,$$

where

I_{MAX} = maximum rated transistor collector current (amperes).

Priority 3

$$\text{Area} = 8.75 \times 10^{-3} \left(2 \times 10^{-6} C_{O_{CB}} V_{BD_{CB}}^{0.83}\right)^{0.58} \quad ,$$

where

$C_{O_{CB}} = C_{RC} V_{RC}^{0.333}$ = corrected collector-to-base capacitance (picofarads),

C_{RC} = collector-to-base capacitance at rated voltage (picofarads),

V_{RC} = rated voltage for collector-to-base capacitance (volts),

$V_{BD_{CB}}$ = collector-to-base breakdown voltage (volts).

Priority 4

$$\text{Area} = 1.19 \times 10^{-2} \theta_{JC}^{-0.94} \quad ,$$

where

θ_{JC} = junction-to-case thermal resistance (degrees Celsius/watt).

Priority 5

$$\text{Area} = 2.79 \theta_{JA}^{-1.70} \quad ,$$

where

θ_{JA} = junction-to-ambient thermal resistance (degrees Celsius/watt).

Collector-to-base junction:

Priority 1

$$\text{Area} = 0.047\theta_{JC}^{-0.89} \quad .$$

Priority 2

$$\text{Area} = 2.72 \times 10^{-3} I_{MAX}^{0.62} \quad .$$

Priority 3

$$\text{Area} = 3.63\theta_{JA}^{-1.47} \quad .$$

Priority 4

$$\text{Area} = 1.13 \times 10^{-2}\left(2 \times 10^{-6} C_{O_{CB}} V_{BD}^{0.83}\right)^{0.39} \quad .$$

Diode junction:

Priority 1

$$\text{Area} = 8.1 \times 10^{-3} I_{MAX}^{1.16}$$

where

I_{MAX} = maximum rated diode currents (amperes) for Zener diodes $= I_{ZM} V_Z$,

I_{ZM} = maximum rated Zener current (amperes),

V_Z = rated Zener voltage (volts).

Priority 2

$$\text{Area} = 0.458\left(2 \times 10^{-6} C_{O_D} V_{BD}^{0.83}\right)^{0.83} \quad ,$$

where

$$C_{O_D} = C_{RD} V_{RD}^{0.333} \quad ,$$

C_{RD} = diode junction capacitance at rated voltage (picofarads),

V_{RD} = rated voltage (volts).

Priority 3

$$\text{Area} = 0.489\theta_{JL}^{-1.21} ,$$

where

θ_{JL} = junction-to-lead thermal resistance (degrees Celsius/watt).

Priority 4

$$\text{Area} = 1.963\theta_{JA}^{-1.32} .$$

(7) Calculate bulk resistance, space charge resistance, and failure current at 100 ns:

$$R_{BLK} = \rho_{BLK}/\text{area} ,$$

$$R_{SC} = \rho_{SC}/\text{area} ,$$

$$I_{F\ 100\ ns} = J_F \mathrm{X}\ \text{area} .$$

(8) Calculate power to damage for pulse duration t:

$$P_D = \left[V_{BDC} \frac{I_{F\ 100\ ns}}{3.162} + \frac{I^2_{F\ 100\ ns}}{10} \left(R_{SC} + R_{BLK} \right) \right] /1000t^{0.5} .$$

3. RESULTS

Appendix A lists a program used to implement the AFWL model, along with the input and resultant data. The model predictions are presented in figure 1 as

$$P_X/P \quad , \text{ for } P_X \geq P ,$$

$$P/P_X \quad , \text{ for } P > P_X ,$$

where

P_X = experimental power to damage,

P = corresponding predicted value,

as a function of the percentage confidence level. The percentage confidence level is defined as the percentage of data points with a ratio less than or equal to the given value. The envelope defined by the five priority models is plotted in figure 2 along with the predictions of the junction capacitance damage model for comparison and a plot of the scatter in the experimental data. The scatter in the experimental data is the ratio of the power to damage for the individual devices and the experimentally defined damage curve presented in the mode previously indicated for the AFWL model predictions. The experimental data base used for this projection includes but is larger than that indicated in appendix A. The total base of 822 devices comprised a test population of 82 P-N junction types. This population includes both germanium devices and specialty devices for which AFWL model data are unavailable.

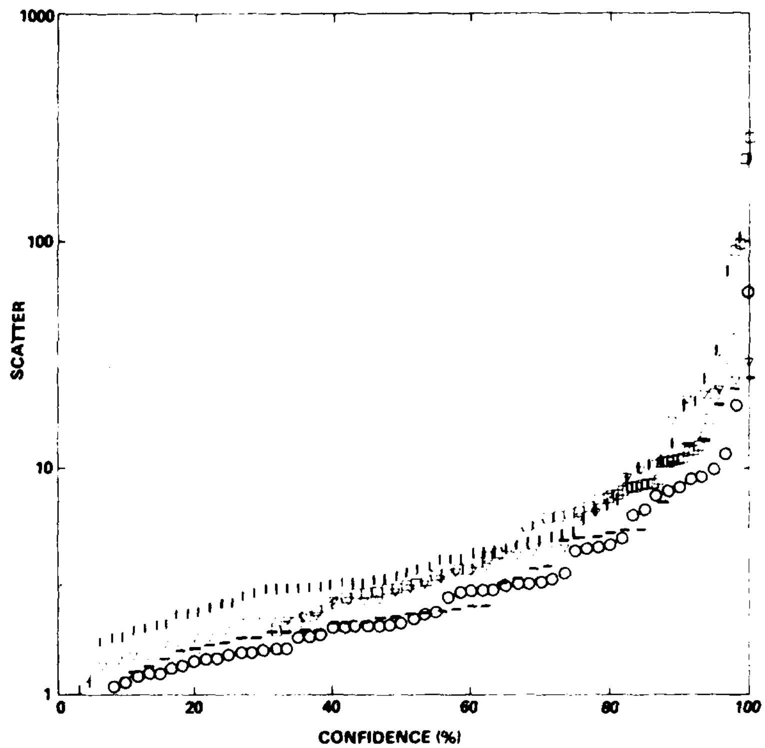

Figure 1. Percentage confidence level versus scatter in data for AFWL model: 0 = priority 1, □ = priority 2, ∇ = priority 3, | = priority 4, and - = priority 5.

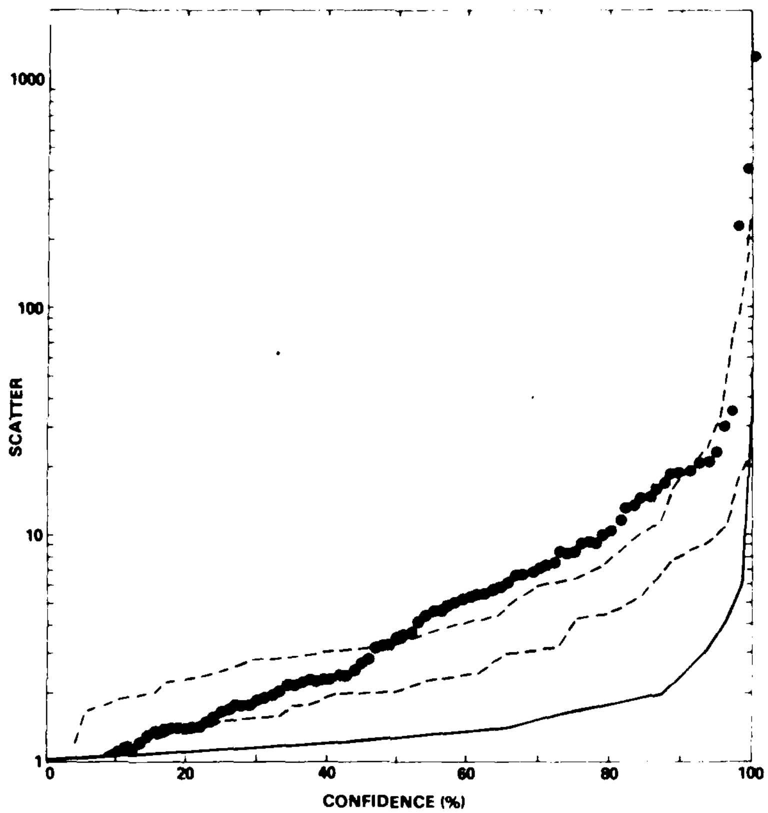

Figure 2. Percentage confidence level versus scatter in data for junction capacitance damage model (solid circles), limits of AFWL damage model (dashed curve), and *experimental data (solid curve).*

4. CONCLUSION AND DISCUSSION

At high confidence levels, the AFWL model represents approximately a doubled improvement over the junction capacitance damage model based on the device population employed in this study. One note of caution: The AFWL model, *like all previous damage models, is for junction reverse* bias only. To project from reverse bias failure to failure under forward bias is fraught with great difficulties. Figure 3 is a histogram of the experimental ratio of power to failure for forward and for reverse bias. (All measurements were made at 0.1-, 1-, and 10-μs pulse durations.) Previous studies have shown that, despite the generally higher power to failure for forward bias, damage is as likely

to occur under forward as under reverse conditions for circuits driven to the failure level,[1,2] The uncertainty indicated in figure 3 must be included in the uncertainty of the damage model predictions in projecting damage characteristics to forward bias.

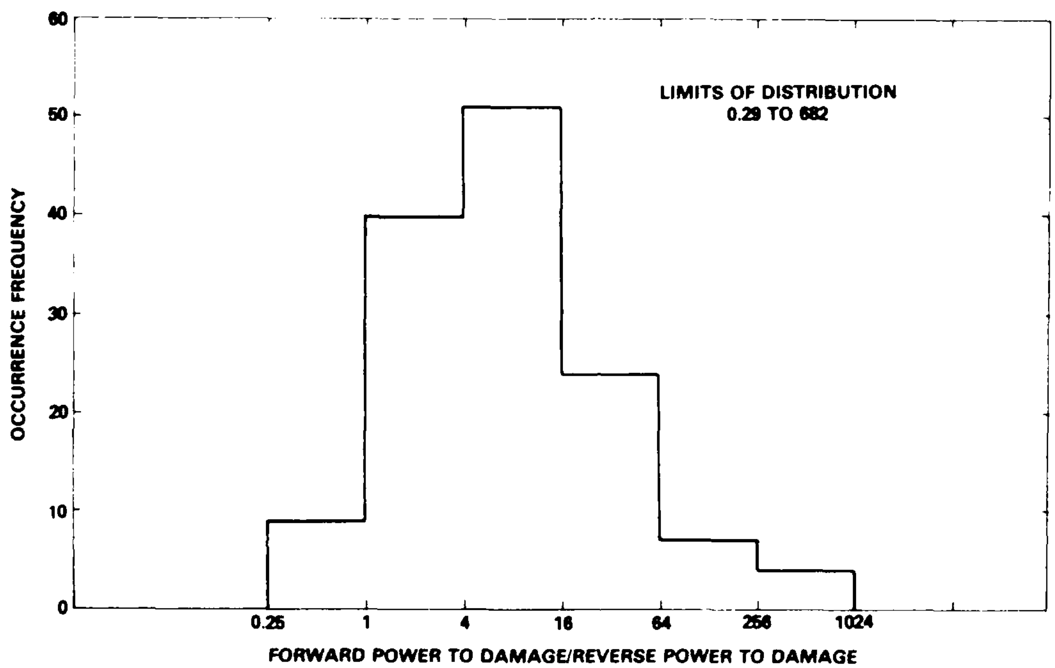

Figure 3. Histogram of ratio of experimental power to damage for forward and reverse junction bias for pulse durations in 0.1- to 10-μs range for 78 percent of P-N junction types included in appendix A.

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[1]*Michael J. Vrabel, EMP Assessment for Army Tactical Communications Systems: Transmission Systems Series No. 3 Radio Terminal Sets AN/TRC-112 and AN/TRC-121 (U), Harry Diamond Laboratories HDL-TR-1807 (May 1977). (SECRET-RESTRICTED DATA)*

[2]*George Gornak et al, EMP Assessment for Army Tactical Communications Systems: Transmission Systems Series No. 1 Radio Terminal Set AN/TRC-145 (U), Harry Diamond Laboratories HDL-TR-1746 (February 1976). (SECRET-RESTRICTED DATA)*

APPENDIX A.--AIR FORCE WEAPONS LABORATORY MODEL CODE, INPUT DATA, AND RESULTS OF PREDICTING BIPOLAR TRANSISTOR AND DIODE FAILURE FOR REVERSE JUNCTION BIAS

```
C   DAT(1,N)=-1: DIODE JUNCTION, 0: C-B JUNCTION, 1: E-B JUNCTION
C   DAT(2,N)=BREAKDOWN VOLTAGE (V)
C   DAT(3,N)= DIODE CAPACITANCE (PF), DEFAULT VALUE=0
C   DAT(4,N)=C-B CAPACITANCE, DEFAULT VALUE=0
C   DAT(5,N)= E-B CAPACITANCE (PF), DEFAULT VALUE=0
C   DAT(6,N)=MAXIMUM RATED COLLECTOR OR DIODE CURRENT(A)
C   DAT(7,N)=JUNCTION-TO -CASE THERMAL RESISTANCE(THETA JC) (C/W)
C   DAT(8,N)=JUNCTION-TO-AMBIENT THERMAL RESISTANCE(THETA JA) (C/W)
C   DAT(9,N)=BREAKDOWN VOLTAGE FOR C-B FOR EMITTER DATA
C   DAT(10,N)=EXPERIMENTAL POWER TO DAMAGE AT 0.1US
C   DAT(11,N)=EXPERIMENTAL POWER TO DAMAGE AT 1 US
C   DAT(12,N)=EXPERIMENTAL POWER TO DAMAGE AT 10 US
      DIMENSION DAT(12,68), DOPE(68), BV(68), RHOSC(68), RHOBLK(68)
      DIMENSION FAILI(68), AREA(5,68), RBLK(5,68), RSC(5,68), CUR(5,68)
      DIMENSION D(5,68), RATIO(5,3,68), BIG(5), MZ(5), NZ(5), SET(5)
      DIMENSION B(5,150), C(5,150), MV(5), RSULT(5,300)
      DIMENSION DEVICE(272), RAT(5,3,68)
      DIMENSION AVG(3,68), BB(200), CC(200), RSLT(400)
      NAMELIST/LISTA/DAT,DEVICE
      READ(5,LISTA)
      WRITE(6,1)
 1    FORMAT(20X,10HBREAKDOWN ,10H   DIODE   ,10H   C-B     ,
     &10H   E-B     ,10HCOLL. CURR,10H THETA JC ,10H THETA JA ,
     &10H  BV C-B  ,10HDAMAGE    ,10HDAMAGE    ,10HDAMAGE    )
      WRITE(6,2)
 2    FORMAT(20X,10H VOLTAGE  ,10H   CAP.   ,10H   CAP.   ,
     &10H   CAP.   ,10H   MAX.   ,30X,10H (0.1US)  ,
     &10H (1.0US)  ,10H (10.US)  )
      WRITE(6,3)
 3    FORMAT(20X,10H (VOLTS)  ,10H   (PF)   ,10H   (PF)   ,
     &10H   (PF)   ,10H   (AMP)  ,10H (C/WATT) ,10H (C/WATT) ,
     &10H (VOLTS)  ,10H (WATTS)  ,10H (WATTS)  ,10H (WATTS)  )
      WRITE(6,4)
 4    FORMAT(2X)
      DO 201 N=1,65
      M=4*(N-1)+1
      MM=M+1
      MMM=MM+1
      MMMM=MMM+1
      WRITE(6,200)DEVICE(M),DEVICE(MM),DEVICE(MMM),DEVICE(MMMM),
     &(DAT(M,N),M=2,12)
 200  FORMAT(2X,4A4,8F10.3,3F10.2)
 201  CONTINUE
      DO 100 N=1,68
      IF(DAT(2,N).EQ.0.) GO TO 100
      DOPE(N)=(4.49E+18)*DAT(2,N)**(-1.5)
 100  CONTINUE
      DO 101 N=1,68
      IF(DOPE(N).EQ.0.) GO TO 101
      BV(N)=(4.07E+12)*(DOPE(N))**(-0.67)
 101  CONTINUE
      DO 102 N=1,68
      IF(DOPE(N).EQ.0.) GO TO 102
      RHOSC(N)=(2.48E+25)*(DOPE(N))**(-1.8)
 102  CONTINUE
      DO 103 N=1,68
      IF(DOPE(N).EQ.0.) GO TO 103
```

```
      RHOBLK(N)=(3.61E+10)*(DOPE(N))**(-0.81)
  103 CONTINUE
      DO 104 N=1,68
      IF(DAT(1,N))105,105,106
  105 FAILI(N)=(8.26E-11)*(DOPE(N))**(0.88)
      GO TO 104
  106 FAILI(N)=(3.84E-11)*(DOPE(N))**(0.88)
  104 CONTINUE
      DO 107 N=1,68
      IF(DAT(1,N))110,109,108
  108 AREA(1,N)=1.47*((2.3E-06)*DAT(5,N)*DAT(2,N)**0.67)**1.05
      AREA(2,N)=(6.34E-04)*(DAT(6,N))**0.82
      AREA(3,N)=(8.75E-03)*(2.E-06*DAT(4,N)*(DAT(9,N))**0.83)**0.58
      IF(DAT(7,N).EQ.0.) GO TO 150
      AREA(4,N)=(1.19E-2)*(DAT(7,N))**(-0.94)
  150 IF(DAT(8,N).EQ.0.) GO TO 107
      AREA(5,N)=2.79*DAT(8,N)**(-1.7)
      GO TO 107
  109 IF(DAT(7,N).EQ.0.) GO TO 151
      AREA(1,N)=0.047*(DAT(7,N))**(-0.89)
  151 AREA(2,N)=(2.72E-03)*(DAT(6,N))**(0.62)
      IF(DAT(8,N).EQ.0.) GO TO 152
      AREA(3,N)=3.63*(DAT(8,N))**(-1.47)
  152 AREA(4,N)=(1.13E-02)*(2.E-06*DAT(4,N)*DAT(2,N)**0.83)**0.39
      GO TO 107
  110 AREA(1,N)=(8.1E-03)*DAT(6,N)**1.16
      AREA(2,N)=0.458*(2.E-06*DAT(3,N)*DAT(2,N)**0.83)**0.83
      IF(DAT(7,N).EQ.0.) GO TO 153
      AREA(3,N)=0.489*DAT(7,N)**(-1.21)
  153 IF(DAT(8,N).EQ.0.) GO TO 107
      AREA(4,N)=1.963*DAT(8,N)**(-1.32)
  107 CONTINUE
      DO 111 N=1,68
      DO 112 M=1,5
      IF(AREA(M,N).EQ.0.) GO TO 112
      RBLK(M,N)=RHOBLK(N)/AREA(M,N)
      RSC(M,N)=RHOSC(N)/AREA(M,N)
      CUR(M,N)=FAILI(N)*AREA(M,N)
  112 CONTINUE
  111 CONTINUE
      DO 116 N=1,68
      DO 113 M=1,5
      D(M,N)=(BV(N)*(CUR(M,N)/3.162)+((CUR(M,N)**2)/10.)*
     &(RSC(M,N)+RBLK(M,N)))/1000.
  113 CONTINUE
  116 CONTINUE
      DO 117 N=1,68
      DO 118 M=1,3
      DO 114 K=1,5
      MM=9+M
      AM=M-1
      IF(D(K,N).EQ.0.) GO TO 114
      RATIO(K,M,N)=DAT(MM,N)/(D(K,N)*3162.*(10.)**(-0.5*AM))
      RAT(K,M,N)=RATIO(K,M,N)
      IF(RATIO(K,M,N).EQ.0.) GO TO 114
      IF(RATIO(K,M,N).GE.1.) GO TO 114
      RATIO(K,M,N)=1./RATIO(K,M,N)
  114 CONTINUE
  118 CONTINUE
  117 CONTINUE
```

```
      WRITE(6,15)
15    FORMAT(2X////)
      WRITE(6,5)
5     FORMAT(2X,123HRATIO OF EXPERIMENTAL POWER TO DAMAGE TO PREDICTED V
     &ALUE FOR 0.1, 1.0, AND 10 USEC PULSE DURATIONS FOR FIVE PRIORITY M
     &ODELS//)
      WRITE(6,6)
6     FORMAT(26X,12H    PRTY 1    ,12H    PRTY 2    ,12H    PRTY 3    ,
     &12H    PRTY 4    ,12H    PRTY 5    /)
      DO 312 L=1,3
      DO 311 N=1,65
      M=4*(N-1)+1
      MM=M+1
      MMM=MM+1
      MMMM=MMM+1
      WRITE(6,310)DEVICE(M),DEVICE(MM),DEVICE(MMM),DEVICE(MMMM),
     &(RAT(K,L,N),K=1,5)
310   FORMAT(10X,4A4,5F12.4)
311   CONTINUE
      WRITE(6,313)
313   FORMAT(2X//)
312   CONTINUE
      DO 800 N=1,68
      DO 801 M=1,3
      AJ=0.
      DO 802 K=1,5
      AVG(M,N)=RATIO(K,M,N)+AVG(M,N)
      IF(RATIO(K,M,N).EQ.0.) GO TO 802
      AJ=1.+AJ
802   CONTINUE
      IF(AVG(M,N).EQ.0.) GO TO 801
      AVG(M,N)=AVG(M,N)/AJ
801   CONTINUE
800   CONTINUE
      DO 803 LL=1,200
      DO 804 N=1,68
      DO 805 M=1,3
      IF(AVG(M,N).EQ.0.) GO TO 805
      IF(AVG(M,N).LE.BIGG) GO TO 805
      BIGG=AVG(M,N)
      MAVG=M
      NAVG=N
805   CONTINUE
804   CONTINUE
      NZAA=1+NZAA
      IF(SETT.EQ.1.) GO TO 806
      IF(BIGG.NE.0.) GO TO 806
      SETT=1.
      MVV=NZAA-1
      MAV=MVV
806   CONTINUE
      BB(NZAA)=BIGG
      BIGG=0.
      AVG(MAVG,NAVG)=0.
803   CONTINUE
      DO 808 N=1,200
      BN=N-1
      AMV=MVV
      CC(N)=100.-BN*(100./AMV)
808   CONTINUE
```

APPENDIX A

```
      MM=0
      DO 880 N=1,MVV
      AVERAG=BB(N)+AVERAG
880   CONTINUE
      AVERAG=AVERAG/AMV
      DO 809 N=1,MVV
      MM=1+MM
      RSLT(MM)=BB(N)
      MM=1+MM
      RSLT(MM)=CC(N)
809   CONTINUE
      DO 130 LL=1,150
      DO 123 N=1,68
      DO 124 M=1,3
      DO 120 K=1,5
      IF(RATIO(K,M,N).EQ.0.) GO TO 120
      IF(RATIO(K,M,N).LE.BIG(K)) GO TO 120
      BIG(K)=RATIO(K,M,N)
      MZ(K)=M
      NZ(K)=N
120   CONTINUE
124   CONTINUE
123   CONTINUE
      NZA=1+NZA
      DO 131 KK=1,5
      IF(SET(KK).EQ.1.) GO TO 131
      IF(BIG(KK).NE.0.) GO TO 131
      SET(KK)=1.
      MV(KK)=NZA-1
131   CONTINUE
      DO 132 KK=1,5
      B(KK,NZA)=BIG(KK)
      BIG(KK)=0.
132   CONTINUE
      DO 133 KK=1,5
      MZZ=MZ(KK)
      NZZ=NZ(KK)
      RATIO(KK,MZZ,NZZ)=0.
133   CONTINUE
130   CONTINUE
      DO 140 N=1,150
      DO 135 K=1,5
      BN=N-1
      AMV=MV(K)
      C(K,N)=100.-BN*(100./(AMV+.0000001))
135   CONTINUE
140   CONTINUE
      DO 142 K=1,5
      MVV=MV(K)
      MM=0
      DO 141 N=1,MVV
      MM=1+MM
      RSULT(K,MM)=B(K,N)
      MM=1+MM
      RSULT(K,MM)=C(K,N)
141   CONTINUE
142   CONTINUE
      WRITE(6,11)
11    FORMAT(2X////)
      WRITE(6,10)
```

```
10    FORMAT(2X,128HRATIO EXPERIMENTAL AND PREDICTED POWER TO DAMAGE VS
     &PERCENTAGE CONFIDENCE LEVEL FOR ALL PULSE DURATIONS FOR FIVE PRIOR
     &ITY MODELS//)
      DO 145 K=1,5
      MJV=(MV(K)+1)*2
      WRITE(6,146)(RSULT(K,M),M=1,MJV)
146   FORMAT(5X,2F9.2,3X,2F9.2,3X,2F9.2,3X,2F9.2,2X,2F9.2)
      WRITE(6,12)
12    FORMAT(2X//)
145   CONTINUE
      WRITE(6,810)
810   FORMAT(2X////)
      WRITE(6,811)
811   FORMAT(2X,124HRATIO OF EXPERIMENTAL AND PREDICTED POWER TO DAMAGE
     &VS PERCENTAGE CONFIDENCE LEVEL FOR AVERAGE VALUE OF FIVE PRIORITY
     &MODELS//)
      MJV=(MAV+1)*2
      WRITE(6,146)(RSLT(M),M=1,MJV)
      WRITE(6,810)
      WRITE(6,881)AVERAG
881   FORMAT(15X,31HARITHMETIC MEAN OF ABOVE DATA =,F9.2)
      STOP
      END
/*
//GO.SYSIN DD *
 &LISTA DAT=0,120,0,11,0,.05,0,357.120,140,52,20,
 1,33,0,0,9,.05,0,357,120,30,16,9,
 0,250,0,16,0,.025,0,0,250,300,80,20,
 1,27,0,0,9,.025,0,0,250,100,44,20,
 0,54,0,17,0,0,0,1000,54,160,70,30,
 1,7,0,0,22,0,0,1000,54,625,112,70,
 0,200,0,4.3,0,.05,0,500,200,50,46,42,
 1,10.2,0,0,5.3,.05,0,500,200,160,48,15,
 0,107,0,142,0,1.5,0,345,107,115,72,44,
 1,7.8,0,0,53,1.5,0,345,107,590,255,110,
 0,45,0,8,0,.03,0,500,45,180,74,30,
 1,5,0,0,0,.03,0,500,45,230,60,16,
 0,108,0,57,0,0,0,476,108,10,10,10,
 1,7.4,0,0,8,0,0,476,108,53,30,18,
 0,93,0,18,0,.6,0,434,93,135,53,20,
 1,8.5,0,0,23,.6,0,434,93,110,78,53,
 0,107,0,15,0,.8,0,303,107,220,85,32,
 1,7.3,0,0,31,.8,0,303,107,400,135,40,
 -1,0,0,0,0,1,0,0,0,2800,2300,2100,
 -1,0,0,0,0,0,0,0,0,4100,2700,1600,
 -1,.64,0,0,0,0,0,0,0,6400,2700,1400,
 -1,2.5,0,0,0,0,0,0,0,3.4,2,1.1,
 -1,115,5.7,0,0,.075,0,0,0,420,80,15,
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APPENDIX A

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4H2N33,4H5(C-,4HB)  ,4H    ,
4H2N33,4H5(E-,4HB)  ,4H    ,
4H2N33,4H6:JA,4HN(C-,4HB)  ,
4H2N33,4H6:JA,4HN(E-,4HB)  ,
4H2N24,4H84(C,4H-B) ,4H    ,
4H2N24,4H84(E,4H-B) ,4H    ,
4H2N37,4H36(C,4H-B) ,4H    ,
4H2N37,4H36(E,4H-B) ,4H    ,
4H2N93,4H0(C-,4HB)  ,4H    ,
4H2N93,4H0(E-,4HB)  ,4H    ,
4H2N24,4H81(C,4H-B) ,4H    ,
4H2N24,4H81(E,4H-B) ,4H    ,
4H2N29,4H07A(,4HC-B),4H    ,
4H2N29,4H07A(,4HE-B),4H    ,
4H2N22,4H22A(,4HC-B),4H    ,
4H2N22,4H22A(,4HE-B),4H    ,
4H1N43,4H84  ,4H    ,4H    ,
4HFS91,4H1-34,4H65  ,4H    ,
4H1N81,4H6   ,4H    ,4H    ,
4H1N21,4HWE  ,4H    ,4H    ,
4H1N91,4H4A  ,4H    ,4H    ,
4H1N75,4H2A  ,4H    ,4H    ,
4HPC11,4H5   ,4H    ,4H    ,
4H1N30,4H26B:,4HJAN ,4H    ,
4H1N36,4H11  ,4H    ,4H    ,
4H1N39,4H95A ,4H    ,4H    ,
4H1N30,4H16B ,4H    ,4H    ,
4H1N41,4H41  ,4H    ,4H    ,
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4H1002,4H    ,4H    ,4H    ,
4H2N28,4H57(C,4H-B) ,4H    ,
4H2N28,4H57(E,4H-B) ,4H    ,
4H2N33,4H75(C,4H-B) ,4H    ,
4H2N33,4H75(E,4H-B) ,4H    ,
4H2N14,4H90:J,4HAN(C,4H-B) ,
4H2N14,4H90:J,4HAN(E,4H-B) ,
4H2N35,4H84(C,4H-B) ,4H    ,
4H2N35,4H84(E,4H-B) ,4H    ,
4H2N28,4H94(C,4H-B) ,4H    ,
4H2N28,4H94(E,4H-B) ,4H    ,
4H2N58,4H29(C,4H-B) ,4H    ,
4H2N58,4H29(E,4H-B) ,4H    ,
4H2N30,4H13:J,4HAN(C,4H-B) ,
4H2N30,4H13:J,4HAN(E,4H-B) ,
4HCA30,4H18(C,4H-B) ,4H    ,
4HCA30,4H18(E,4H-B) ,4H    ,
4H2N16,4H13:J,4HAN(C,4H-B) ,
4H2N16,4H13:J,4HAN(E,4H-B) ,
4H2N14,4H85:J,4HAN(C,4H-B) ,
4H2N14,4H85:J,4HAN(E,4H-B) ,
4H2N34,4H39(C,4H-B) ,4H    ,
4H2N34,4H39(E,4H-B) ,4H    ,
4H2N70,4H6:JA,4HN(C-,4HB)  ,
4H2N70,4H6:JA,4HN(E-,4HB)  ,
4H1N25,4H80  ,4H    ,4H    ,
4H1N75,4H1A:J,4HAN  ,4H    ,
4H1N48,4H5B:J,4HAN  ,4H    ,
4H1N29,4H91B: 4HJAN ,4H    ,
4H1N30,4H25E:,4HJAN ,4H    ,
4HM010,4H54  ,4H    ,4H    ,
4H1N74,4H6A:J,4HAN  ,4H    ,
4H1N64,4H5:JA,4HN   ,4H    ,
4H1N12,4H02RA,4H:JAN,4H    ,
4H1N17,4H31A:,4HJAN ,4H    ,
 &END.
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	BREAKDOWN VOLTAGE (VOLTS)	DIODE CAP. (PF)	C-B CAP. (PF)	E-B CAP. (PF)	COLL. CURR MAX. (AMP)	THETA JC (C/WATT)	THETA JA (C/WATT)	BV C-B (VOLTS)	DAMAGE (0.1US) (WATTS)	DAMAGE (1.0US) (WATTS)	DAMAGE (10.US) (WATTS)
2N328A(C-B)	120.000	0.0	11.000	0.0	0.050	0.0	357.000	120.000	140.00	52.00	20.00
2N328A(E-B)	33.000	0.0	0.0	9.000	0.050	0.0	357.000	120.000	30.00	16.00	9.00
2N335(C-B)	250.000	0.0	16.000	0.0	0.025	0.0	0.0	250.000	300.00	80.00	20.00
2N335(E-B)	27.000	0.0	0.0	9.000	0.025	0.0	0.0	250.000	100.00	44.00	20.00
2N336:JAN(C-B)	54.000	0.0	17.000	0.0	0.0	0.0	1000.000	54.000	160.00	70.00	30.00
2N336:JAN(E-B)	7.000	0.0	0.0	22.000	0.0	0.0	1000.000	54.000	625.00	112.00	70.00
2N2484(C-B)	200.000	0.0	4.300	0.0	0.050	0.0	500.000	200.000	50.00	46.00	42.00
2N2484(E-B)	10.200	0.0	0.0	5.300	0.050	0.0	500.000	200.000	160.00	48.00	15.00
2N3736(C-B)	107.000	0.0	142.000	0.0	1.500	0.0	345.000	107.000	115.00	72.00	44.00
2N3736(E-B)	7.800	0.0	0.0	53.000	1.500	0.0	345.000	107.000	590.00	255.00	110.00
2N930(C-B)	45.000	0.0	8.000	0.0	0.030	0.0	500.000	45.000	180.00	74.00	30.00
2N930(E-B)	5.000	0.0	0.0	0.0	0.030	0.0	500.000	45.000	230.00	60.00	16.00
2N2481(C-B)	108.000	0.0	57.000	0.0	0.0	0.0	476.000	108.000	10.00	10.00	10.00
2N2481(E-B)	7.400	0.0	0.0	8.000	0.0	0.0	476.000	108.000	53.00	30.00	18.00
2N2907A(C-B)	93.000	0.0	18.000	0.0	0.600	0.0	434.000	93.000	135.00	53.00	20.00
2N2907A(E-B)	8.500	0.0	0.0	23.000	0.600	0.0	434.000	93.000	110.00	78.00	53.00
2N2222A(C-B)	107.000	0.0	15.000	0.0	0.800	0.0	303.000	107.000	220.00	85.00	32.00
2N2222A(E-B)	7.300	0.0	0.0	31.000	0.800	0.0	303.000	107.000	400.00	135.00	40.00
1N4384	0.0	0.0	0.0	0.0	1.000	0.0	0.0	0.0	2800.00	2300.00	2100.00
FS911-3465	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4100.00	2700.00	1600.00
1N816	0.640	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6400.00	2700.00	1400.00
1N21WE	2.500	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.40	2.00	1.10
1N914A	115.000	5.700	0.0	0.0	0.075	0.0	0.0	0.0	420.00	80.00	15.00
1N752A	5.700	40.000	0.0	0.0	0.0	0.0	0.0	0.0	2300.00	340.00	83.00
PC115	154.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3300.00	1350.00	510.00
1N3026B:JAN	18.000	2320.000	0.0	0.0	0.0	0.0	0.0	0.0	170000.00	53720.00	17000.00
1N3611	0.0	0.0	0.0	0.0	2.000	0.0	0.0	0.0	3000.00	3000.00	3000.00
1N3995A	4.700	0.0	0.0	0.0	0.0	0.0	0.0	0.0	262446.00	83000.00	26244.00
1N3016B	6.800	0.0	0.0	0.0	0.0	0.0	0.0	0.0	130000.00	41079.00	13000.00
1N4141	0.0	0.0	0.0	0.0	3.000	0.0	0.0	0.0	80000.00	25280.00	8000.00
1002	0.0	0.0	0.0	0.0	1.000	0.0	132.000	0.0	6700.00	2117.00	670.00
2N2857(C-B)	40.000	0.0	1.000	0.0	0.040	0.0	909.000	40.000	120.00	16.00	12.40
2N2857(E-B)	5.400	0.0	0.0	0.0	0.040	0.0	909.000	40.000	8.20	2.60	0.84
2N3375(C-B)	87.000	0.0	0.0	0.0	1.500	15.000	0.0	87.000	1800.00	1000.00	500.00
2N3375(E-B)	6.000	0.0	0.0	0.0	1.500	15.000	0.0	87.000	1300.00	440.00	230.00
2N1490:JAN(C-B)	120.000	0.0	0.0	0.0	6.000	2.400	0.0	120.000	7000.00	2300.00	700.00
2N1490:JAN(E-B)	14.000	0.0	0.0	0.0	6.000	2.400	0.0	120.000	13000.00	3800.00	1300.00
2N3584(C-B)	315.000	0.0	0.0	0.0	5.000	5.000	0.0	315.000	1200.00	370.00	120.00
2N3584(E-B)	9.100	0.0	0.0	0.0	5.000	5.000	0.0	315.000	10000.00	2150.00	490.00
2N2894(C-B)	36.000	0.0	6.000	0.0	0.200	0.0	500.000	36.000	170.00	50.00	14.00
2N2894(E-B)	6.400	0.0	0.0	0.0	0.200	0.0	500.000	36.000	30.00	19.00	12.00
2N5829(C-B)	30.000	0.0	0.800	0.0	0.030	0.0	909.000	30.000	47.00	17.00	6.00
2N5829(E-B)	3.000	0.0	0.0	0.0	0.030	0.0	909.000	30.000	22.00	10.00	4.30
2N3013:JAN(C-B)	40.000	0.0	5.000	0.0	0.200	0.0	500.000	40.000	100.00	21.00	4.30
2N3013:JAN(E-B)	5.000	0.0	0.0	0.0	0.200	0.0	500.000	40.000	52.00	31.50	20.00
CA3018(C-B)	53.000	0.0	0.580	0.0	0.050	0.0	200.000	53.000	64.00	20.00	5.80
CA3018(E-B)	7.100	0.0	0.0	0.600	0.050	0.0	200.000	53.000	22.00	10.00	4.00
2N1613:JAN(C-B)	123.000	0.0	25.000	0.0	0.500	0.0	222.000	123.000	3200.00	2100.00	1400.00
2N1613:JAN(E-B)	8.800	0.0	0.0	0.0	0.500	0.0	222.000	123.000	750.00	340.00	160.00
2N1485:JAN(C-B)	205.000	0.0	0.0	0.0	3.000	7.000	0.0	205.000	1700.00	1100.00	700.00
2N1485:JAN(E-B)	18.000	0.0	0.0	0.0	3.000	7.000	0.0	205.000	290000.00	30000.00	3100.00
2N3439(C-B)	575.000	0.0	0.0	0.0	1.000	36.000	0.0	575.000	78.00	27.00	10.00
2N3439(E-B)	9.400	0.0	0.0	0.0	1.000	36.000	0.0	575.000	2200.00	620.00	180.00
2N706:JAN(C-B)	25.000	0.0	6.000	0.0	0.0	0.0	500.000	25.000	93.00	17.00	2.80
2N706:JAN(E-B)	5.000	0.0	0.0	0.0	0.0	0.0	500.000	25.000	50.00	18.00	6.80

1N2580	536.000	0.0	0.0	0.0	12.000	0.0	0.0	0.0	170000.00	53720.00	17000.00
1N751A:JAN	5.100	265.000	0.0	0.0	0.0	0.0	0.0	0.0	25500.00	2500.00	240.00
1N485B:JAN	270.000	6.000	0.0	0.0	0.200	0.0	0.0	0.0	2000.00	435.00	100.00
1N2991B:JAN	36.000	730.000	0.0	0.0	0.0	0.0	0.0	0.0	100000.00	31600.00	10000.00
1N3025B:JAN	16.000	310.000	0.0	0.0	0.0	0.0	0.0	0.0	140000.00	14000.00	1400.00
MC1054	505.000	85.000	0.0	0.0	0.0	0.0	0.0	0.0	44.00	33.50	25.00
1N746A:JAN	3.300	350.000	0.0	0.0	0.0	0.0	0.0	0.0	153800.00	20000.00	2600.00
1N645:JAN	725.000	17.000	0.0	0.0	0.400	0.0	0.0	0.0	1625.00	580.00	500.00
1N1202RA:JAN	514.000	0.0	0.0	0.0	12.000	0.0	0.0	0.0	9000.00	1000.00	100.00
1N1731A:JAN	1580.000	0.0	0.0	0.0	0.350	0.0	0.0	0.0	5700.00	2000.00	800.00

RATIO OF EXPERIMENTAL POWER TO DAMAGE TO PREDICTED VALUE FOR 0.1, 1.0, AND 10 USEC PULSE DURATIONS FOR FIVE PRIORITY MODELS

	PRTY 1	PRTY 2	PRTY 3	PRTY 4	PRTY 5
2N328A(C-B)	0.0	0.4908	0.3246	0.2566	0.0
2N328A(E-B)	0.2935	1.1214	0.0	0.0	0.4775
2N335(C-B)	0.0	2.1016	0.0	0.4870	0.0
2N335(E-B)	1.0266	6.0125	0.0	0.0	0.0
2N336:JAN(C-B)	0.0	0.0	1.2035	0.2287	0.0
2N336:JAN(E-B)	2.7970	0.0	0.0	0.0	22.5051
2N2484(C-B)	0.0	0.2111	0.2291	0.1349	0.0
2N2484(E-B)	3.2438	3.1116	0.0	0.0	2.3489
2N3736(C-B)	0.0	0.0468	0.2426	0.0772	0.0
2N3736(E-B)	1.0583	0.5799	0.0	0.0	3.7889
2N930(C-B)	0.0	0.5655	0.4471	0.3349	0.0
2N930(E-B)	0.0	3.8508	0.0	0.0	1.9122
2N2481(C-B)	0.0	0.0	0.0340	0.0096	0.0
2N2481(E-B)	0.6896	0.0	0.0	0.0	0.5647
2N2907A(C-B)	0.0	0.0917	0.3774	0.2006	0.0
2N2907A(E-B)	0.4763	0.2446	0.0	0.0	1.1137
2N2222A(C-B)	0.0	0.1323	0.3834	0.3547	0.0
2N2222A(E-B)	1.2536	0.6251	0.0	0.0	1.9563
1N4384	0.0	0.0	0.0	0.0	0.0
FS911-3465	0.0	0.0	0.0	0.0	0.0
1N816	0.0	0.0	0.0	0.0	0.0
1N21WE	0.0	0.0	0.0	0.0	0.0
1N914A	1.5322	0.6474	0.0	0.0	0.0
1N752A	0.0	0.7561	0.0	0.0	0.0
PC115	0.0	0.0	0.0	0.0	0.0
1N3026B:JAN	0.0	2.4439	0.0	0.0	0.0
1N3611	0.0	0.0	0.0	0.0	0.0
N3995A	0.0	0.0	0.0	0.0	0.0
1N3016B	0.0	0.0	0.0	0.0	0.0
1N4141	0.0	0.0	0.0	0.0	0.0
1OD2	0.0	0.0	0.0	0.0	0.0
2N2857(C-B)	0.0	0.2968	0.6753	0.4912	0.0
2N2857(E-B)	0.0	0.1162	0.0	0.0	0.2018
2N3375(C-B)	0.5589	0.6745	0.0	0.0	0.0
2N3375(E-B)	0.0	1.0331	0.0	0.9786	0.0
2N1490:JAN(C-B)	0.4832	1.2612	0.0	0.0	0.0
2N1490:JAN(E-B)	0.0	6.1278	0.0	3.2309	0.0
2N3584(C-B)	0.2236	0.3401	0.0	0.0	0.0
2N3584(E-B)	0.0	4.1091	0.0	3.7194	0.0
2N2894(C-B)	0.0	0.1465	0.3755	0.3383	0.0

2N2894(E-B)	0.0	0.1313	0.0	0.0	0.3090
2N5829(C-B)	0.0	0.1184	0.2253	0.1963	0.0
2N5829(E-B)	0.0	0.2229	0.0	0.0	0.3058
2N3013:JAN(C-B)	0.0	0.0912	0.2337	0.2185	0.0
2N3013:JAN(E-B)	0.0	0.1837	0.0	0.0	0.4323
CA3018(C-B)	0.0	0.1587	0.0448	0.3406	0.0
CA3018(E-B)	4.3283	0.3267	0.0	0.0	0.0519
2N1613:JAN(C-B)	0.0	2.7164	3.7253	4.2633	0.0
2N1613:JAN(E-B)	0.0	1.9870	0.0	0.0	2.4925
2N1485:JAN(C-B)	0.3695	0.5718	0.0	0.0	0.0
2N1485:JAN(E-B)	0.0	279.2483	0.0	228.1203	0.0
2N3439(C-B)	0.1022	0.0728	0.0	0.0	0.0
2N3439(E-B)	0.0	3.4632	0.0	5.3573	0.0
2N706:JAN(C-B)	0.0	0.0	0.1657	0.1679	0.0
2N706:JAN(E-B)	0.0	0.0	0.0	0.0	0.4157
1N2580	2.9173	0.0	0.0	0.0	0.0
1N751A:JAN	0.0	1.6703	0.0	0.0	0.0
1N485B:JAN	3.1721	2.2258	0.0	0.0	0.0
1N2991B:JAN	0.0	3.6068	0.0	0.0	0.0
1N3025B:JAN	0.0	10.6319	0.0	0.0	0.0
HD1054	0.0	0.0043	0.0	0.0	0.0
1N746A:JAN	0.0	6.5441	0.0	0.0	0.0
1N645:JAN	1.5848	0.5301	0.0	0.0	0.0
1N1202RA:JAN	0.1524	0.0	0.0	0.0	0.0
1N1731A:JAN	8.2311	0.0	0.0	0.0	0.0

2N328A(C-B)	0.0	0.5765	0.3813	0.3013	0.0
2N328A(E-B)	0.4950	1.8913	0.0	0.0	0.8052
2N335(C-B)	0.0	1.7722	0.0	0.4107	0.0
2N335(E-B)	1.4284	8.3658	0.0	0.0	0.0
2N336:JAN(C-B)	0.0	0.0	1.6650	0.3164	0.0
2N336:JAN(E-B)	1.5850	0.0	0.0	0.0	12.7532
2N2484(C-B)	0.0	0.6141	0.6664	0.3925	0.0
2N2484(E-B)	3.0773	2.9519	0.0	0.0	2.2284
2N3736(C-B)	0.0	0.0927	0.4803	0.1528	0.0
2N3736(E-B)	1.4465	0.7926	0.0	0.0	5.1785
2N930(C-B)	0.0	0.7351	0.5812	0.4354	0.0
2N930(E-B)	0.0	3.1767	0.0	0.0	1.5774
2N2481(C-B)	0.0	0.0	0.1075	0.0303	0.0
2N2481(E-B)	1.2343	0.0	0.0	0.0	1.0107
2N2907A(C-B)	0.0	0.1139	0.4685	0.2491	0.0
2N2907A(E-B)	1.0679	0.5485	0.0	0.0	2.4972
2N2222A(C-B)	0.0	0.1616	0.4685	0.4333	0.0
2N2222A(E-B)	1.3380	0.6672	0.0	0.0	2.0879
1N4384	0.0	0.0	0.0	0.0	0.0
FS911-3465	0.0	0.0	0.0	0.0	0.0
1N816	0.0	0.0	0.0	0.0	0.0
1N21WE	0.0	0.0	0.0	0.0	0.0
1N914A	0.9229	0.3899	0.0	0.0	0.0
1N752A	0.0	0.3535	0.0	0.0	0.0
PC115	0.0	0.0	0.0	0.0	0.0
1N3026B:JAN	0.0	2.4421	0.0	0.0	0.0
1N3611	0.0	0.0	0.0	0.0	0.0
1N3995A	0.0	0.0	0.0	0.0	0.0
1N3016B	0.0	0.0	0.0	0.0	0.0
1N4141	0.0	0.0	0.0	0.0	0.0
1002	0.0	0.0	0.0	0.0	0.0
2N2857(C-B)	0.0	0.1251	0.2847	0.2071	0.0

2N2857(E-B)	0.0	0.1165	0.0	0.0	0.2023
2N3375(C-B)	0.9819	1.1850	0.0	0.0	0.0
2N3375(E-B)	0.0	1.1057	0.0	1.0474	0.0
2N1490:JAN(C-B)	0.5020	1.3104	0.0	0.0	0.0
2N1490:JAN(E-B)	0.0	5.6643	0.0	2.9865	0.0
2N3584(C-B)	0.2180	0.3316	0.0	0.0	0.0
2N3584(E-B)	0.0	2.7937	0.0	2.5288	0.0
2N2894(C-B)	0.0	0.1362	0.3492	0.3146	0.0
2N2894(E-B)	0.0	0.2631	0.0	0.0	0.6189
2N5829(C-B)	0.0	0.1354	0.2577	0.2245	0.0
2N5829(E-B)	0.0	0.3205	0.0	0.0	0.4396
2N3013:JAN(C-B)	0.0	0.0606	0.1552	0.1451	0.0
2N3013:JAN(E-B)	0.0	0.3520	0.0	0.0	0.8282
CA3018(C-B)	0.0	0.1568	0.0443	0.3365	0.0
CA3018(E-B)	6.2214	0.4696	0.0	0.0	0.0747
2N1613:JAN(C-B)	0.0	5.6372	7.7308	8.8474	0.0
2N1613:JAN(E-B)	0.0	2.8485	0.0	0.0	3.5732
2N1465:JAN(C-B)	0.7561	1.1699	0.0	0.0	0.0
2N1465:JAN(E-B)	0.0	91.3512	0.0	74.6255	0.0
2N3439(C-B)	0.1119	0.0797	0.0	0.0	0.0
2N3439(E-B)	0.0	3.0864	0.0	4.7743	0.0
2N706:JAN(C-B)	0.0	0.0	0.0958	0.0971	0.0
2N706:JAN(E-B)	0.0	0.0	0.0	0.0	0.4732
1N2580	2.9152	0.0	0.0	0.0	0.0
1N751A:JAN	0.0	0.5178	0.0	0.0	0.0
1N485B:JAN	2.1818	1.5309	0.0	0.0	0.0
1N2991B:JAN	0.0	3.6042	0.0	0.0	0.0
1N3025B:JAN	0.0	3.3621	0.0	0.0	0.0
MD1054	0.0	0.0104	0.0	0.0	0.0
1N746A:JAN	0.0	2.6911	0.0	0.0	0.0
1N645:JAN	1.7887	0.5983	0.0	0.0	0.0
1N1202RA:JAN	0.0535	0.0	0.0	0.0	0.0
1N1731A:JAN	9.1330	0.0	0.0	0.0	0.0

2N328A(C-B)	0.0	0.7011	0.4637	0.3665	0.0
2N328A(E-B)	0.6806	3.3641	0.0	0.0	1.4324
2N335(C-B)	0.0	1.4011	0.0	0.3247	0.0
2N335(E-B)	2.0532	12.0251	0.0	0.0	0.0
2N336:JAN(C-B)	0.0	0.0	2.2565	0.4288	0.0
2N336:JAN(E-B)	3.1326	0.0	0.0	0.0	25.2057
2N2484(C-B)	0.0	1.7731	1.9242	1.1331	0.0
2N2484(E-B)	3.0411	2.9171	0.0	0.0	2.2021
2N3736(C-B)	0.0	0.1791	0.9281	0.2952	0.0
2N3736(E-B)	1.9731	1.0811	0.0	0.0	7.0640
2N930(C-B)	0.0	0.9424	0.7451	0.5582	0.0
2N930(E-B)	0.0	2.6788	0.0	0.0	1.3302
2N2481(C-B)	0.0	0.0	0.3398	0.0958	0.0
2N2481(E-B)	2.3419	0.0	0.0	0.0	1.9177
2N2907A(C-B)	0.0	0.1359	0.5591	0.2972	0.0
2N2907A(E-B)	2.2947	1.1785	0.0	0.0	5.3658
2N2222A(C-B)	0.0	0.1924	0.5577	0.5159	0.0
2N2222A(E-B)	1.2536	0.6251	0.0	0.0	1.9563
1N4384	0.0	0.0	0.0	0.0	0.0
FS911-3465	0.0	0.0	0.0	0.0	0.0
1N816	0.0	0.0	0.0	0.0	0.0
1N21WE	0.0	0.0	0.0	0.0	0.0
1N914A	0.5472	0.2312	0.0	0.0	0.0
1N752A	0.0	0.2729	0.0	0.0	0.0

PC115	0.0	0.0	0.0	0.0	0.0
1N3026B:JAN	0.0	2.4439	0.0	0.0	0.0
1N3611	0.0	0.0	0.0	0.0	0.0
1N3995A	0.0	0.0	0.0	0.0	0.0
1N3016B	0.0	0.0	0.0	0.0	0.0
1N4141	0.0	0.0	0.0	0.0	0.0
1002	0.0	0.0	0.0	0.0	0.0
2N2857(C-B)	0.0	0.3067	0.6978	0.5076	0.0
2N2857(E-B)	0.0	0.1190	0.0	0.0	0.2067
2N3375(C-B)	1.5526	1.8736	0.0	0.0	0.0
2N3375(E-B)	0.0	1.8278	0.0	1.7314	0.0
2N1490:JAN(C-B)	0.4832	1.2612	0.0	0.0	0.0
2N1490:JAN(E-B)	0.0	6.1278	0.0	3.2309	0.0
2N3584(C-B)	0.2236	0.3401	0.0	0.0	0.0
2N3584(E-B)	0.0	2.0135	0.0	1.8225	0.0
2N2894(C-B)	0.0	0.1206	0.3092	0.2786	0.0
2N2894(E-B)	0.0	0.5254	0.0	0.0	1.2361
2N5829(C-B)	0.0	0.1511	0.2877	0.2505	0.0
2N5829(E-B)	0.0	0.4358	0.0	0.0	0.5978
2N3013:JAN(C-B)	0.0	0.0392	0.1005	0.0940	0.0
2N3013:JAN(E-B)	0.0	0.7067	0.0	0.0	1.6628
CA3018(C-B)	0.0	0.1438	0.0406	0.3086	0.0
CA3018(E-B)	7.8696	0.5940	0.0	0.0	0.0944
2N1613:JAN(C-B)	0.0	11.8843	16.2980	18.6519	0.0
2N1613:JAN(E-B)	0.0	4.2389	0.0	0.0	5.3173
2N1485:JAN(C-B)	1.5216	2.3543	0.0	0.0	0.0
2N1485:JAN(E-B)	0.0	29.8507	0.0	24.3853	0.0
2N3439(C-B)	0.1311	0.0933	0.0	0.0	0.0
2N3439(E-B)	0.0	2.8335	0.0	4.3832	0.0
2N706:JAN(C-B)	0.0	0.0	0.0499	0.0506	0.0
2N706:JAN(E-B)	0.0	0.0	0.0	0.0	0.5653
1N2580	2.9173	0.0	0.0	0.0	0.0
1N751A:JAN	0.0	0.1572	0.0	0.0	0.0
1N485B:JAN	1.5861	1.1129	0.0	0.0	0.0
1N2991B:JAN	0.0	3.6068	0.0	0.0	0.0
1N3025B:JAN	0.0	1.0632	0.0	0.0	0.0
HD1054	0.0	0.0246	0.0	0.0	0.0
1N746A:JAN	0.0	1.1063	0.0	0.0	0.0
1N645:JAN	4.8762	1.6311	0.0	0.0	0.0
1N1202RA:JAN	0.0169	0.0	0.0	0.0	0.0
1N1731A:JAN	11.5525	0.0	0.0	0.0	0.0

1.59	33.33	1.58	31.67	1.58	30.00	1.55	28.33	1.53	26.67
1.52	25.00	1.45	23.33	1.45	21.67	1.43	20.00	1.34	16.33
1.32	16.67	1.25	15.00	1.25	13.33	1.23	11.67	1.14	10.00
1.08	8.33	1.07	6.67	1.06	5.00	1.03	3.33	1.02	1.67
0.0	0.0								

279.25	100.00	231.36	99.28	96.10	98.55	91.35	97.83	40.72	97.10
29.85	96.38	25.50	95.65	21.36	94.93	16.51	94.20	13.74	93.48
12.55	92.75	12.03	92.03	11.88	91.30	10.97	90.58	10.90	89.86
10.79	89.13	10.72	88.41	10.63	87.68	8.78	86.96	8.61	86.23
8.59	85.51	8.45	84.78	8.40	84.06	8.37	83.33	8.29	82.61
7.99	81.88	7.61	81.16	7.56	80.43	7.39	79.71	7.36	78.99
7.34	78.26	6.95	77.54	6.83	76.81	6.62	76.09	6.54	75.36
6.38	74.64	6.36	73.91	6.30	73.19	6.19	72.46	6.13	71.74
6.13	71.01	6.01	70.29	5.66	69.57	5.64	68.84	5.58	68.12
5.44	67.39	5.20	66.67	4.74	65.94	4.49	65.22	4.33	64.49
4.24	63.77	4.11	63.04	4.09	62.32	3.85	61.59	3.80	60.87
3.66	60.14	3.61	59.42	3.61	58.70	3.60	57.97	3.46	57.25
3.37	56.52	3.36	55.80	3.36	55.07	3.26	54.35	3.18	53.62
3.12	52.90	3.11	52.17	3.09	51.45	3.06	50.72	3.02	50.00
2.95	49.28	2.94	48.55	2.94	47.83	2.92	47.10	2.85	46.38
2.84	45.65	2.83	44.93	2.83	44.20	2.79	43.48	2.72	42.75
2.69	42.03	2.66	41.30	2.56	40.58	2.44	39.86	2.44	39.13
2.44	38.41	2.35	37.68	2.29	36.96	2.23	36.23	2.13	35.51
2.10	34.78	2.04	34.06	2.01	33.33	1.99	32.61	1.93	31.88
1.90	31.16	1.89	30.43	1.89	29.71	1.87	28.99	1.83	28.26
1.82	27.54	1.77	26.81	1.77	26.09	1.77	25.36	1.75	24.64
1.73	23.91	1.72	23.19	1.68	22.46	1.67	21.74	1.67	21.01
1.63	20.29	1.63	19.57	1.60	18.84	1.60	18.12	1.54	17.39
1.53	16.67	1.50	15.94	1.48	15.22	1.43	14.49	1.41	13.77
1.40	13.04	1.36	12.32	1.32	11.59	1.31	10.87	1.26	10.14
1.26	9.42	1.26	8.70	1.18	7.97	1.18	7.25	1.17	6.52
1.12	5.80	1.11	5.07	1.11	4.35	1.11	3.62	1.08	2.90
1.06	2.17	1.06	1.45	1.03	0.72	0.0	0.0		

29.43	100.00	24.64	97.78	22.59	95.56	22.33	93.33	20.05	91.11
16.30	88.89	10.44	86.67	9.95	84.44	9.31	82.22	7.73	80.00
6.44	77.78	6.04	75.56	4.44	73.33	4.37	71.11	4.28	68.89
4.12	66.67	3.86	64.44	3.73	62.22	3.51	60.00	3.48	57.78
3.23	55.56	3.08	53.33	2.94	51.11	2.86	48.89	2.66	46.67
2.65	44.44	2.62	42.22	2.61	40.00	2.26	37.78	2.24	35.56
2.16	33.33	2.13	31.11	2.13	28.89	2.08	26.67	1.92	24.44
1.79	22.22	1.79	20.00	1.72	17.78	1.67	15.56	1.50	13.33
1.48	11.11	1.43	8.89	1.34	6.67	1.20	4.44	1.08	2.22
0.0	0.0								

228.12	100.00	104.34	98.41	74.63	96.83	32.99	95.24	24.39	93.65
19.78	92.06	18.65	90.48	12.96	88.89	10.64	87.30	10.43	85.71
10.30	84.13	8.85	82.54	7.41	80.95	6.89	79.37	6.55	77.78
5.95	76.19	5.36	74.60	5.10	73.02	4.98	71.43	4.83	69.84
4.77	68.25	4.58	66.67	4.45	65.08	4.38	63.49	4.37	61.90
4.26	60.32	4.02	58.73	3.99	57.14	3.90	55.56	3.72	53.97
3.59	52.38	3.39	50.79	3.36	49.21	3.32	47.62	3.24	46.03
3.23	44.44	3.23	42.86	3.18	41.27	3.16	39.68	3.08	38.10

2.99	36.51	2.99	34.92	2.97	33.33	2.96	31.75	2.94	30.16
2.82	28.57	2.73	26.98	2.55	25.40	2.53	23.81	2.43	22.22
2.33	20.63	2.31	19.05	2.30	17.46	2.05	15.87	2.04	14.29
1.97	12.70	1.94	11.11	1.82	9.52	1.79	7.94	1.73	6.35
1.13	4.76	1.05	3.17	1.02	1.59	0.0	0.0		

25.21	100.00	22.51	97.78	19.25	95.56	13.39	93.33	12.75	91.11
10.59	88.89	7.06	86.67	5.37	84.44	5.32	82.22	5.18	80.00
4.96	77.78	4.94	75.56	4.84	73.33	3.79	71.11	3.57	68.89
3.27	66.67	3.24	64.44	2.50	62.22	2.49	60.00	2.41	57.78
2.35	55.56	2.31	53.33	2.27	51.11	2.23	48.89	2.20	46.67
2.11	44.44	2.09	42.22	2.09	40.00	1.96	37.78	1.96	35.56
1.92	33.33	1.91	31.11	1.77	28.89	1.77	26.67	1.67	24.44
1.66	22.22	1.62	20.00	1.58	17.78	1.43	15.56	1.33	13.33
1.24	11.11	1.24	8.89	1.21	6.67	1.11	4.44	1.01	2.22
0.0	0.0								

RATIO OF EXPERIMENTAL AND PREDICTED POWER TO DAMAGE VS PERCENTAGE CONFIDENCE LEVEL FOR AVERAGE VALUE OF FIVE PRIORITY MODELS

253.68	100.00	231.38	99.39	96.10	98.79	82.99	98.18	66.88	97.58
59.05	96.97	40.72	96.36	27.12	95.76	21.15	95.15	19.91	94.55
18.67	93.94	15.61	93.33	15.37	92.73	14.17	92.12	12.81	91.52
12.65	90.91	11.76	90.30	11.61	89.70	11.55	89.09	10.74	88.48
10.65	87.88	10.63	87.27	10.52	86.67	10.37	86.06	9.95	85.45
9.17	84.85	9.13	84.24	8.88	83.64	8.23	83.03	7.41	82.42
7.25	81.82	7.17	81.21	7.04	80.61	6.78	80.00	6.76	79.39
6.71	78.79	6.69	78.18	6.62	77.58	6.61	76.97	6.56	76.36
6.54	75.76	6.47	75.15	6.36	74.55	6.18	73.94	6.00	73.33
5.99	72.73	5.51	72.12	5.44	71.52	5.42	70.91	5.24	70.30
5.04	69.70	4.98	69.09	4.90	68.48	4.78	67.88	4.70	67.27
4.68	66.67	4.68	66.06	4.46	65.45	4.41	64.85	4.33	64.24
4.33	63.64	4.17	63.03	4.15	62.42	3.93	61.82	3.91	61.21
3.88	60.61	3.88	60.00	3.80	59.39	3.71	58.79	3.71	58.18
3.66	57.58	3.61	56.97	3.61	56.36	3.61	55.76	3.60	55.15
3.57	54.55	3.54	53.94	3.52	53.33	3.37	52.73	3.36	52.12
3.35	51.52	3.25	50.91	3.21	50.30	3.08	49.70	3.01	49.09
2.98	48.48	2.95	47.88	2.92	47.27	2.92	46.67	2.92	46.06
2.90	45.45	2.88	44.85	2.83	44.24	2.79	43.64	2.75	43.03
2.72	42.42	2.71	41.82	2.70	41.21	2.70	40.61	2.69	40.00
2.66	39.39	2.63	38.79	2.56	38.18	2.44	37.58	2.44	36.97
2.44	36.36	2.43	35.76	2.41	35.15	2.41	34.55	2.38	33.94
2.33	33.33	2.30	32.73	2.29	32.12	2.24	31.52	2.24	30.91
2.23	30.30	2.22	29.70	2.21	29.09	2.19	28.48	2.13	27.88
2.11	27.27	2.10	26.67	2.10	26.06	2.08	25.45	2.02	24.85
2.00	24.24	1.98	23.64	1.98	23.03	1.94	22.42	1.93	21.82
1.92	21.21	1.89	20.61	1.86	20.00	1.82	19.39	1.80	18.79
1.79	18.18	1.78	17.58	1.77	16.97	1.74	16.36	1.73	15.76
1.72	15.15	1.71	14.55	1.67	13.94	1.67	13.33	1.67	12.73
1.65	12.12	1.64	11.52	1.64	10.91	1.61	10.30	1.61	9.70
1.60	9.09	1.60	8.48	1.57	7.88	1.54	7.27	1.54	6.67

1.40	6.06	1.35	5.45	1.32	4.85	1.25	4.24	1.12	3.64
1.11	3.03	1.10	2.42	1.08	1.82	1.06	1.21	1.03	0.61
0.0	0.0								

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